The Quest for the Perfectly Reliable LLD, or *Should Electronic Line Leak Detectors Have an Annual Test of Operation?*

This article is reprinted by permission of the author and the publishers of LUSTLine. The full article originally appeared in LUSTLine Bulletin 36.

by Marcel Moreau
Marcel Moreau is a nationally recognized petroleum storage specialist whose column, **Tank-nically Speaking**, is a regular feature of LUSTLine.
If there are technical issues that you would like to have Marcel discuss, let him know at marcel.moreau@juno.com.

My first encounter with the electronic line leak detector (ELLD) "test of operation" issue came a few years ago during a compliance inspection. The recordkeeping at the facility was pretty good, but there was no record of an annual test of operation of the ELLD. The maintenance person said that he had checked with the manufacturer to obtain test procedures and had been told that the device did not need to be tested.

At the time, this statement seemed to me to be a bit presumptuous on the part of the manufacturer. Nevertheless, the rules did say that test procedures were to be performed "in accordance with the manufacturer's requirements," so the manufacturer did seem to have some ground to stand on.

I have since heard the question, "Do electronic line leak detectors need to be tested?", many times from inspectors and have followed discussions concerning the issue with Internet interest groups. There are two main schools of thought on the issue:

- *The "proof is in the pudding" school. This view holds that, "The rule says a test should be done, and there is only one true test of operation and that is to see if the device can actually find a leak"—a view held primarily by regulators.*
- *The "father knows best" school. This view holds that, "I build these things and I know how they work. These devices are pretty smart, can tell when they are not working right, and don't need any additional testing"—a view held primarily by some manufacturers. This view is also popular with UST owners who have invested in ELLDs, in part, to avoid the cost of annual testing of mechanical devices.*

Although I believed the points made by both sides had some validity, my own tendency has been to lean toward the regulatory view of "the proof is in the pudding." Having done a little more research into the matter, however, I am beginning to lean toward the "father knows best" school.

The Electronic LLD and the Testing Issue

For the first 30 years after its introduction in the mid-1950s, the LLD remained an entirely mechanical device (see "Of Blabbermouths and Tattletales," *LUSTLine* #29). Since the implementation of the federal rules, however, a number of manufacturers have developed LLDs that are considerably more sophisticated than the original mechanical models and rely on electronic components to do their job. Although the mechanical devices (MLLDs) are still the most common type in service, the ELLDs are making headway in the marketplace.

Annual testing of MLLDs has been a requirement of the fire codes since long before the federal rule. The federal UST rule (and most state UST rules) have adopted this requirement as well. Typical language states that "an annual test of the operation of the leak detector must be conducted in accordance with the manufacturer's requirements" (40 CFR 280.44(a)).

The testing of MLLDs is fairly straightforward. Because all of the working parts are concealed and the MLLD is self-contained, there is no way to test it other than to generate a leak and see if the MLLD responds. The typical test procedure involves connecting a testing device into the piping system at the crash valve at the base of the dispenser. The testing device typically includes pressure gauges and a small valve that can be carefully adjusted to allow three gallons per hour (gph) of product to leak out of the piping and into a suitable container.

The "test of operation" issue, however, becomes more complex with ELLDs. These devices are usually capable of conducting more accurate 0.2 or 0.1 gph tests, in addition to the 3 gph test. Because the federal definition of a line leak detector is written as a performance standard (detecting 3 gph leaks at 10 psi in one hour), the annual test of operation of LLDs applies only the 3 gph function of ELLDs. There is no requirement in the federal rules to evaluate the ability of the ELLD to detect leaks of 0.2 or 0.1 gph on an annual basis.

The Question Please...

The debate concerning ELLD test procedures boils down to this point: many regulators want to continue the tradition of testing operation by generating leaks and seeing if they are detected; some manufacturers insist that their ELLDs are completely selftesting and need no additional evaluation. Note that not all manufacturers claim that their ELLDs are self-testing. In fact, some state that the test of operation should consist of generating a leak and verifying that it is detected. To understand the bases for the opposing opinions, we need to understand a little more about the operating principles of ELLDs and the types of "self-testing" they are capable of conducting.

Types of ELLDs and HowThey Work

There are two basic types of ELLDs: flow-based and pressure-based. Both types attempt to evaluate the integrity of the piping immediately
after each customer has finished dispensing product. The test may require from less than a minute to as long as 10 minutes to complete. If
another customer arrives and turns on the pump, the test is aborted and restarted when this customer is finished dispensing. In general, both types of ELLDs have the ability to turn the pump on and off and to communicate in the form of displays and/or printers. They also have some computational and/or logic circuitry that can determine if a piping run is tight and evaluate, to some degree, how well the ELLD itself is functioning.

Pressure-Based ELLDs

Pressure-based ELLDs are the most common type of ELLD. These ELLDs monitor the pressure in the line after the pump has been turned off. A check valve in the system is used to maintain some pressure in the piping. A leak in the piping will reduce the amount of liquid in the pipe and produce a loss of pressure in the piping that can be measured. A pressure transducer—a device that converts changes in pressure to changes in voltage—is installed in the piping to detect pressure changes. The bigger the leak in the pipe, the faster the pressure in the pipe will drop. If the pressure drops more than a certain amount in a set interval of time, then a failed test results. Brands of pressure-based ELLDs differ principally in how much pressure is held in the pipe at the beginning of the test, the length of time during which the pressure is monitored, and the number of times the test is repeated before a leak is declared. The common use of flexible piping in today's UST systems has presented a bit of a challenge to pressure-based ELLDs. In a rigid piping system, very small losses of liquid will produce fairly large pressure drops, because the volume of the piping is relatively constant over the operating range of pressures that submersible pumps produce. In a flexible piping system, however, the range of pressures normally encountered (0 to 30 psi) produces relatively large changes in the volume of the piping system. Like a balloon (though to a much lesser degree), the flexible piping expands as pressure increases and contracts as pressure is reduced. The contraction of the piping has the effect of maintaining some pressure in the piping as liquid leaks out, thereby prolonging the time required for the pressure in the pipe to drop a given amount. In a rigid piping system, the pressure drop in the piping due to a 3 gph leak is quite rapid. In a flexible piping system, the pressure drops at a much more leisurely pace. Because pressure-based ELLDs monitor pressure change over time to determine whether a leak is present, the device must use a longer test interval to detect a 3 gph leak in flexible piping than in rigid piping. Pressure-based ELLDs must be programmed at installation so that the length of the test interval is adjusted for the flexibility and length of the piping system in which it is installed. In some models, this information must be entered into the device manually. In other models, a 3 gph leak is created in the piping at the time of installation, and the device is operated in a "learn" mode, whereby a series of tests are run to empirically determine the length of the test interval, based on the pressure decay curve that is actually present.

How Pressure-Based ELLDs Test Themselves

There is no question that pressure-based ELLDs can conduct a certain amount of self-testing. Because the device controller can operate the pump on its own, the controller knows that when the pump is off, the pressure should be at the approximate holding pressure of the check valve; when the pump is on, the pressure should be at the operating pressure of the pump. If the measured pressure is outside of these ranges,
then the controller knows that something is not right and a warning can be activated. The warnings will not only determine whether the transducer is malfunctioning, but may also identify other system problems [e.g., running out of product (pump on, but line pressure too low), or a defective pump control that keeps the pump motor running all the time (pump supposedly off, but line pressure too high)]. The comparison of expected versus actual pressure readings is typically conducted as part of the protocol for the 0.2 or 0.1 gph tests. The 0.2 gph tests are initiated whenever the

system has not pumped product for some period of time (typically about a half hour) and in all but the most active 24-hour facilities are usually conducted on a nightly basis. Thus the operating condition of the transducer is typically evaluated on a nightly basis, and the successful completion of a 0.2 gph test is a reasonably reliable indicator that the ELLD is functioning properly. Although I have not investigated all available brands of ELLDs, I expect that there is significant variation in the sophistication of the selftesting that is conducted by the different models. In addition, many of these devices have evolved over time so that earlier software versions may not self-check to the same level as later versions. To guard against improper programming, some ELLD models establish their default piping (the type of piping assumed to be present unless the installer reprograms the ELLD) as a fairly long run of the most flexible piping type. This assumption lengthens the test interval significantly, which is likely to result in frequent "false alarms" if the piping is, in fact, a more rigid variety. Little can be done to thwart the person who might intentionally program the ELLD for operation in a rigid piping system (when the piping is actually a flexible variety) to reduce this "false alarm" rate.

Flow-Based ELLDs

Flow-based ELLDs typically work by keeping the pump motor operating after the customer has hung up the nozzle. This procedure maintains the piping at operating pressure. The ELLD controller then closes an isolation valve at the pump end of the line. The closing of this valve separates the piping into what I will call the "pump side," which is very short and extends from the pump motor to the isolation valve (in some cases the valve is inserted in the pump manifold in the traditional LLD port), and the "dispenser side," which contains the bulk of the piping and extends from the isolation valve at the pump to the dispenser. After the isolation valve is closed, the pump side and the dispenser side remain open to one another via a small passageway in which a flow-sensing device is installed. The pump motor continues to run during the test period to maintain a constant (operating) pressure on the pump side of the isolation valve. In a tight piping system, the dispenser side of the isolation valve will maintain the original (operating) pressure, and there will be no flow through the small passageway, because the pressures on both the pump and dispenser sides of the piping will remain equal. If the dispenser side of the piping has a leak, however, the pressure will drop on the dispenser side of the isolation valve. Liquid will now flow through the flow-sensing pathway, because the pressure is greater on the pump side than the pressure on the dispensing side of the piping. This flow rate is measured. If it exceeds the threshold set for the device, a failed test is declared. In flow-based ELLDs, the pressure in the entire piping run during the test period is maintained at a constant level, because any product leaked from the dispenser side of the piping will be replaced with product from the pump side. Because the test pressure is constant, there is no need to take into consideration variations in leak rate due to pressure changes in the pipe. The ELLD test protocol is the same whether the device is installed in rigid or flexible piping.

How Flow-Based ELLDs Test Themselves

Flow-based ELLDs are capable of some fairly rigorous self-tests. In some devices, after the completion of a 3 gph test, a small bypass valve on the dispenser side of the isolation valve is opened. This valve generates a calibrated 3 gph leak of product from the dispenser side back into the tank. The ELLD then checks whether it can correctly measure this simulated leak with the flow sensor. If it can, then everything is fine; if it can't, then the device communicates a warning to the operator that the system is not operating properly. Another flow-sensing brand simply keeps the flow-sensing pathway open while the pump is dispensing fuel and checks whether the flow sensor registers flow. While this approach is not as quantitative as the approach described previously, this particular flowmeter has no moving parts, so calibration is not a big issue.

And the Answer Is...

So, are ELLD self-tests sufficient to meet the regulatory standard of "annual test of operation...conducted in accordance with the manufacturer's requirements" or not? Well, it depends...

For Pressure-Based ELLDs

For pressure-based ELLDs, I think the answer is a little murky. Some devices seem to offer a reasonably comprehensive test of operation. The main omission is that the ability to detect a 3 gph leak in a specific piping run is not determined. But the EPA interpretation of the LLD test requirement is that a specific leak rate does not need to be detected (http://www.epa.gov/swerust1/ compend/rd.htm, question 16). Thus this omission does not seem significant according to EPA's reading of the rules.I suspect that some other brands and older models of pressure-based ELLDs probably fall short of a thorough self-test. I can think of two items that would serve as helpful compliance evaluation tools for both inspectors and storage system owners. One would be a list of ELLD devices that includes the manufacturer's official recommendations for the "annual test of operation" for that device. This information would be useful to compliance inspectors who need to know whether documentation of a field test must be produced or whether the manufacturer believes that the ELLD's internal testing is sufficient to meet the regulatory requirements. The second item would be an independent review of each ELLD model that a manufacturer claims is "self-testing" to evaluate whether that claim seems reasonable or specious. These items are beyond the scope of this article. If there is enough interest, however, perhaps EPA could fund such a review, or the National Work Group on Leak Detection Evaluations might consider undertaking such a review.

For Flow-Based ELLDs

Flow-based ELLDs that generate quantitative leaks and determine whether they are correctly detected should meet most everyone's definition of a self-test. Flow-based ELLDs that use a nonquantitative flow test seem to provide a reasonable test of operation. All of the flow-based ELLDs of which I am aware fall into one of these two categories.

For Those Who Are Still Dissatisfied

My reading of the regulations is that the privilege of deciding what a "test of operation" is rests with the manufacturer of the device. The disagreement arises because of the varying definitions of "operation." My dictionary says that "operation" means "the quality or state of being functional," and that "functional" means "performing or able to perform its regular function." These definitions leave lots of room for manufacturers and regulators to have differing opinions about what is meant by "test of operation." To tilt the definition in the regulatory direction would require a specific definition of "test of operation." Such a definition might read, "`test of operation' shall mean a procedure to confirm that a LLD will detect a leak of 3 gph by simulating a 3 gph leak and verifying that the LLD responds by shutting off the flow, restricting the flow, or sounding an alarm. Manufacturer's recommendations should be followed when conducting the test of operation." In the absence of a regulatory definition for "test of operation," however, the federal regulations and the dictionary give the manufacturer of the LLD wide latitude in setting its own definition.

My Two Cents

My own thinking has evolved such that I would rather have a well-engineered, self-testing device that evaluates itself on a daily (or nearly daily) basis than a non-self-testing device that is evaluated by a person of uncertain competency on an annual basis. I've been somewhat reassured in researching this article that the most popular ELLDs do a fair amount of self-checking that will realistically tell the facility operator (if he or she is in a mood to listen) whether the ELLD is functional. While the self-checking may not take into account all possible contingencies, there seem to be clear benefits to automatic self-testing versus an annual test of operation conducted by a fallible human.

Either way, there are no guarantees that *every* leak will be detected in a timely fashion. As former OUST employee David Wiley has been known to say, "We should not let the perfect become the enemy of the good." It would be helpful to have some real-world data that would reveal the number/percentage of the following events:

- The number of piping leaks that have occurred where the ELLD did not detect the leak;
- The number of times service personnel have responded to customer reports of ELLD warning lights or messages; and
- The number of times service personnel responding to other problems have *discovered* ELLDs in warning mode.

My gut instinct (what's yours?) is that the number of instances where a leak was missed by a malfunctioning ELLD will run a distant third to the instances where a warning light resulted in a service call or was completely ignored. Maybe what is really needed is an annual test to verify that facility operators understand their leak detection equipment.

ELLDs –Tips for Inspectors

- If an internal diagnostics system detects a problem, some ELLDs will not proceed with the more sensitive 0.2 gph test. If an ELLD has not completed a 0.2 gph test in the last week, it may indicate that the device is not working correctly (unless the facility is extraordinarily busy).

- Read alarm messages carefully (this task may require consulting an owner’s manual or technical manual for the device) to understand what the ELLD is telling you (and the owner).
- For pressure-based ELLDs, consult the programming manual for the device to find out how to verify that the type and length of piping that have been programmed into the ELLD are consistent with the piping actually present at the facility.
- Get a copy of the California State Water Resources Control Board’s (SWRCB’s) new booklet, *Understanding Line Leak Detector Systems.* The booklet discusses the technological principles of LLDs and provides an overview of installation, inspection, maintenance, and special features of these devices. While you’re at it, check out SWRCB’s *Understanding Automatic Tank Gauging Systems* booklet. To obtain copies of either booklet, fax your request to the SWRCB UST Program at (916) 341-5707, call (916) 341-5775, or visit its Web site at http://www.swrcb.ca.gov/cwphome/ust.